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Microbial Population in Rhizospheric and Non-Rhizospheric Soils of Soybean Crop

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ABSTRACT

The current research paper aims at the study of the microbial population in rhizospheric and non-rhizospheric soils of soybean crop. The Phosphate solubilizing bacteria and fungi play a central role in increasing the soil fertility and promote plant growth. Plate count method for bacterial and fungal population analysis showed that the bacterial and fungal population in rhizospheric and non-rhizospheric soil of Sitapur region was higher compared to rhizospheric and non-rhizospheric soils of other two regions i.e. Lucknow and Kanpur. Kanpur ranked second having higher bacterial and fungal populations, whereas Lucknow ranked third. It was observed that the microbial count was higher in rhizospheric soils of the entire three regions i.e. Sitapur, Kanpur and Lucknow compared to the non-rhizospheric soils.

1) INTRODUCTION

Soil offers significant habitat mainly for bacteria and fungi. The rhizosphere is the most active part of the soil where beneficial and harmful microbial activities take place. The rhizospheric soil harbours many bacteria and fungi [1, 2]. It has been known that soil bacteria and fungi play a crucial role in various biogeochemical cycles and are responsible for cycling of organic matter in the environment [3, 4, 5]. It has been reported that there is a positive relationship between plant diversity and soil microbial biomass [6, 7, 8]. Soil microorganisms exist in huge amount in soil as long as carbon source is present. A large amount of bacteria are present in the soil but due to their small size they are smaller in biomass whereas fungal population are less but they are dominant in the soil biomass when the soil is not disturbed [9]. Organic matter present in the soil provides energy for growth and supply carbon for the formation of new cells in the microorganisms. It Microbes present in the soil require regular supply of organic matter for the survival in the soil. It has been reported that bacteria are normally less effective in converting organic carbon to new cells whereas fungus release less carbon dioxide into the atmosphere and are more efficient in converting carbon to form new cells. It has also been reported that microbial population changes rapidly with quantity and quality of organic matter present in the soil [9]. The present study investigates the microbial (bacterial and fungal) population in rhizospheric and non-rhizospheric soil of soybean crops of three different regions i.e. Sitapur, Lucknow and Kanpur.

2) MATERIALS AND METHODS

Collection of soil samples: The rhizospheric and non-rhizospheric soil samples were collected from three different regions i.e. Sitapur, Lucknow and Kanpur in sterilized polythene bags with a soil auger and were taken to the laboratory. The samples were mixed evenly and processed for microbial diversity.

Microbiological analysis:

(a) **Microbial Population:**Total microbial population of rhizospheric and non-rhizospheric soils were isolated by dilution plate technique. The soil sample were serially diluted in sterile normal saline solution and 10µ of diluted suspension was spread on sterilized and cooled nutrient agar for bacterial population; on Czapek's-Dox agar medium for fungal populations and Pikovskaya medium for phosphate solubilizers [10] using standard microbiological methods. Each sample was replicated

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three times and incubated at 28 ± 2 ^{0}C for total bacterial, fungal and phosphate solubilizing microbial population.

(b) **Total Bacterial and Fungal Population:**The pour plate technique was used to determine the number of bacterial and fungal colonies. The total number of colonies appeared were counted and calculated in colony forming unites per gram of soil sample (cfu g^{-1}).

3) RESULTS

3.1 Microbial analysis

Both groups of microorganisms (fungi and bacteria) were evaluated quantitatively by using serial dilution plate technique. Average count of bacterial (**Table No.1**) and fungal (**Table No.2**) population were expressed as log of **(**cfu g^{-1}**)** dry soil.

3.2 Determination of Bacterial population

Plate count of the bacteria showed that the bacterial population of rhizospheric soil of Sitapur region (cfu $g^{-1}293\times 10^5$) was higher compared to rhizospheric soil of other two regions i.e. Lucknow (cfu g^{-1} 287×10^5) and Kanpur (cfu g^{-1} 290×10^5). In case of non-rhizospheric soil, the bacterial population in Sitapur region ranged between (cfu g^{-1} 274.33×10^5 to 10.0×10^7). Kanpur ranked second having bacterial population between cfu g^{-1} 252×10^5 to 9×10^7 whereas Lucknow ranked third. If we compare rhizospheric and non-rhizospheric soil, there are several factors hypothesized to influence the microbial populations such as age of particular area for species colonizations, competitions among microorganisms, physical and chemical factors of soil and predation. The microbial population was high in rhizospheric soil as compared to non-rhizospheric soil this may be due to the availability of nutrients released by the root exudates around root zone of the plant. The bacterial count was higher in rhizospheric soil of the entire three regions i.e. Sitapur, Kanpur and Lucknow as compare to the non-rhizospheric soil.

3.3 Fungal population analysis

Study on fungal population showed that the fungal count was higher in case of rhizospheric soil (cfu g^{-1} 27.67×10^3) of Sitapur region compared to the non-rhizospheric soil (cfu $g^{-1}21\times10^3$). The fungal population of rhizospheric soil of Kanpur region ranged between cfu $g^{-1}19.67\times10^3$ to 3×10^5 followed by Lucknow region (cfu $g^{-1}18\times10^3$ to 2.67×10^5). The result showed that the non- rhizospheric soil of Kanpur region ranked second (cfu $g^{-1}19.67\times10^3$) in case of fungal population in non-rhizospheric soil whereas Lucknow region ranked third having fungal population ranged between (cfu $g^{-1}14.33\times10^3$ to 2.67×10^5) respectively.

3.4 Determination of phosphate solubilising bacterial populations

Observation revealed that phosphate solubilising bacterial population was higher in rhizospheric soil (cfu $g^{-1}17\times10^5$) of Sitapur region compared to the non-rhizospheric soil (11×10^5). The phosphate solubilizing bacterial population of rhizospheric soil of Kanpur region ranged between (cfu $g^{-1}15\times10^5$ to 2.33×10^7) followed by Lucknow region (cfu $g^{-1}12\times10^5$to 2.33×10^7). The rhizospheric soil of Kanpur region and Lucknow region showed the equal number of phosphate solubilising bacterial count (cfu $g^{-1}2.33\times10^7$). The similar result was observed in case of non-rhizospheric soil of Kanpur and Lucknow region (cfu $g^{-1}9.33\times10^7$).

3.5 Determination of phosphate solubilising fungal population

Table.1 Total bacterial population in the rhizospheric and non-rhizospheric soil of three distinct regions i.e. Lucknow, Sitapur and Kanpur at three different dilutions (cfu $g^{-1}\times10^{-5}$, 10^{-6} and 10^{-7}).

Sampling site	Non-rhizospheric soil (Dilution factor)			Rhizospheric soil (Dilution factor)		
	10^{-5}	10^{-6}	10^{-7}	10^{-5}	10^{-6}	10^{-7}
Lucknow	243.33 ± 8.12	68.33 ±2.03	9.0 ± 0.58	287 ± 3.22	84.00 ± 8.40	13.33 ± 2.41
Sitapur	274.33 ± 6.70	74.33 ± 4.71	10.0 ± 1.16	293 ± 2.33	94.00 ± 2.08	17.00 ± 1.16
Kanpur	252.33 ± 5.05	68.33 ± 1.45	9.0 ± 0.58	290 ± 3.48	89.67 ± 1.77	15.00 ± 1.53
CV%	4.54	7.57	15.15	1.97	9.88	20.34
F value	5.61*	1.27^{ns}	0.5^{ns}	0.84^{ns}	0.97^{ns}	1.07^{ns}

Average of three replications ± SE, CV% - coefficient of variation. *= significant at 0.05, ns= non-significant

Table. 2 Total fungal population in the rhizospheric and non-rhizospheric soil of three distinct regions i.e. Lucknow, Sitapur and Kanpur at three different dilutions (cfu $g^{-1}\times10^{-3}$, 10^{-4} and 10^{-5}).

Sampling site	Non-rhizospheric soil(Dilution factor)			Rhizospheric soil(Dilution factor)		
	10^{-3}	10^{-4}	10^{-5}	10^{-3}	10^{-4}	10^{-5}
Lucknow	14.33 ± 2.61	6.67 ± 0.67	2.67 ± 1.20	18.00 ± 1.16	8.67 ± 0.88	2.67 ± 2.70
Sitapur	21.00 ± 4.36	6.67 ± 0.88	2.00 ± 0.58	27.67 ± 5.24	8.00 ± 1.16	3.67 ± 0.33
Kanpur	19.67 ± 0.88	10.0 ± 2.08	3.33 ± 0.88	19.67 ± 0.88	10.0 ± 2.08	3.00 ± 0.33
CV %	28.11	30.30	59.95	24.96	28.56	30.30
F value	1.41ns	2.00ns	0.52ns	2.71ns	0.48ns	0.88ns

Average of three replications ± SE, CV% - coefficient of variation.*= significant at 0.05, ns= non-significant

Experimental analysis revealed that phosphate solubilising fungal population was higher in case of rhizospheric soil (cfu $g^{-1}12.67\times10^3$) of Sitapurregion compared to the non-rhizospheric soil (cfu $g^{-1}11.00\times10^3$). The phosphate solubilising fungal population of rhizospheric soil of Kanpur region ranged between (cfu $g^{-1}11.33\times10^3$ to 1.67×10^5) followed by Lucknow region (cfu g^{-1} 9.67×10^3 1.33×10^5). The result showed that the non-rhizospheric soil of Kanpur region ranked second (cfu $g^{-1}9.00\times10^3$) in case of phosphate solubilising fungal population in non-rhizospheric soil whereas Lucknow region ranked third having phosphate solubilising fungal population ranged between (cfu g^{-1} 7.00×10^3 to 1.33×10^5) respectively.

Table.3 Total phosphate solubilising bacterial population in the rhizospheric and non-rhizospheric soil of three distinct regions i.e. Lucknow, Sitapur and Kanpur at three different dilutions (cfu $g^{-1} \times 10^{-5}$, 10^{-6} and 10^{-7}).

Sampling site	Non-rhizospheric soil Dilution factors			Rhizospheric soil Dilution factors		
	10^{-5}	10^{-6}	10^{-7}	10^{-5}	10^{-6}	10^{-7}
Lucknow	9.33 ± 0.33	4.00 ± 0.58	1.67 ± 0.33	12 ± 1.16	7.33 ± 0.88	2.33 ± 0.33
Sitapur	11.33 ± 0.67	6.67 ± 0.67	2.33 ± 0.33	17 ± 1.53	10.67 ± 1.20	3.00 ± 0.58
Kanpur	9.33 ± 0.33	4.33 ± 0.67	2.00 ± 0.00	15 ± 0.88	8.33 ± 0.88	2.33 ± 0.33
CV%	18.75	2.11	23.57	14.73	29.73	29.17
F value	1.00ns	5.18*	1.50ns	4.07ns	2.93ns	0.80ns

Average of three replications ± SE, CV% - coefficient of variation. *= significant at 0.05, ns= non-significant

Table.4 Total phosphate solubilising fungal population in the rhizospheric and non-rhizospheric soil of three distinct regions i.e. Lucknow, Sitapur and Kanpur at three different dilutions (cfu $g^{-1} \times 10^{-3}$, 10^{-4} and 10^{-5}).

Sampling site	Non-rhizospheric soil (Dilution factor)			Rhizospheric soil (Dilution factor)		
	10^{-3}	10^{-4}	10^{-5}	10^{-3}	10^{-4}	10^{-5}
Lucknow	7.0 ± 0.58	4.67 ± 0.88	1.33 ± 0.33	9.67 ± 0.33	3.67 ± 0.67	1.33 ± 0.33
Sitapur	11.0 ± 1.53	5.67 ± 0.33	2.33 ± 0.33	12.67 ± 0.33	5.33 ± 0.88	1.67 ± 0.33
Kanpur	9.0 ± 1.53	4.33 ± 0.88	1.33 ± 0.33	11.33 ± 0.88	6.00 ± 1.53	1.67 ± 0.33
CV%	24.85	26.41	34.64	8.91	37.71	37.12
F value	2.40ns	0.87ns	3.00ns	6.78*	1.22ns	0.33ns

Average of three replications ± SE, CV% - coefficient of variation. *= significant at 0.05, ns= non-significant

4) DISCUSSION

Soil microorganisms are present in large numbers in soil as long as carbon source is present. A huge number of bacteria are present in soil but they have smaller biomass because of their small size. The fungal population is less but they are dominant in soil biomass. As comparison to bacteria, fungi are less tolerant to soil disturbances [9]. Soil microorganisms are responsible for the enhancement of soil fertility [11].

There was a significant difference in the bacterial and fungal population in the soybean crop field soil. The microbial community depends upon the plant species and soil type [12]. The plant species such as clover, bean or alfalfa had a significant effect on soil pattern [12]. The population and composition of the microbial population in soil depends upon the plant growth and the production of exudates from plant root [13].

5) CONCLUSION

The study revealed that the microbial population in rhizospheric soil in all three regions i.e. Lucknow, Sitapur and Kanpur was higher compared to non-rhizospheric soil. Based on the result it may be concluded that microbial population was more in rhizospheric soil of Sitapur region compared to Lucknow and Kanpur region. Least microbial population was recorded in non- rhizospheric soil in all three regions.

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